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A Study on Spin Coating Method for Cover Layer of Blu-ray Disc

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Abstract

Spin coating method for cover layer of Blu-ray Disc (BD) has been studied. The effects of resin viscosity, spinning speed, spinning time, and variables on ski-jump of cover layer were investigated. A vacuum chuck was newly designed to minimize the ski-jump effect.

Optical storage media, including CD (compact disc) and DVD (digital versatile disc) have been developed rapidly last three decades. Recently, in order to meet the demand for increasing optical disc capacity to serve high-definition quality of picture and sound, Blu-ray Disc (BD) having capacity over 23 GB is being developed. BD requires a transparent cover layer of 100 μm on the top of recording layer.[1] Decre and Vromans presented two possible approach for the cover layer; spin coating and bonding of a polycarbonate (PC) sheet.[2] Among these technologies, spin coating is a good method due to some advantages including small residual focusing error and low processing cost. However, a major problem of spin coating is the ski-jump, which is made at the rim area of disc because of viscoelastic nature of polymer. Chang *et al.* have investigated a spin coating technique for making 100 μm thick cover layer,[3] but the ski-jump problem still remains unsolved.

In this study, we investigated the effects of resin viscosity, spinning speed, spinning time, and variables on the uniformity, thickness, ski-jump, and ski-jump width of cover layer. And we newly designed a vacuum chuck in order to decrease ski-jump and ski-jump width of cover layer.

A 1.1 mm thick polycarbonate (PC) disc deposited with multi-layered film including recording layer was used as a substrate. UV-curable resins with various viscosities (3500, 5900, 10600, and 15000 cP at 25 °C) for spin coating on PC substrates were prepared. Their shrinkage on UV-curing showed 5.0 ± 0.2 %, and the transmittance at 405 nm for 100 μm thickness was 92 %. The resin was dispensed on the center position of a PC substrate. A vacuum chuck was newly designed to minimize a ski-jump during spin coating.

Fig. 1 shows changes in the thickness of the cover layer versus spinning time with different viscosity. The data presented in Fig. 1 are the average of 32 points on the coated disk except ski-jump area. As the resin viscosity increases, higher spinning speed is required for 100 μm thick cover layer with 30 sec spinning time. It has been found that uniform 100 μm thick cover layer can be obtained independent of a resin viscosity. The overall thickness of cover layer was 100 ± 2 μm as shown in Fig. 2. We investigated the changes in ski-jump and ski-jump width with the increasing resin viscosity and spinning speed at which we obtained 100 μm thick cover layer. Additionally, we newly designed a vacuum chuck and compared the effect of vacuum chuck on ski-jump

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and ski-jump width. The results are shown in Table 1. When a conventional vacuum chuck was used, the ski jumps of cover layer were more than 50 μm regardless of a viscosity. Using newly designed vacuum chuck, ski-jump and ski-jump width decreased remarkably. Especially, at the viscosity of 15000 cP and at the spinning speed of 1700 rpm the ski-jump and the ski-jump width were 6.2 μm and 0.6 mm, respectively. We also investigated the effect of minor parameters such as dosing amount, spinning speed for dosing, and spin acceleration rate on the uniformity, thickness, ski-jump, and ski-jump width of cover layer. These minor parameters have little effect on the above characteristics of the cover layer.

In conclusion, the resin viscosity does not effect the uniformity of cover layer. However, the higher the resin viscosity and spinning speed, the smaller the ski-jump and ski-jump with of cover layer. Newly designed vacuum chuck works very well to reduce the ski-jump o f a cover layer.

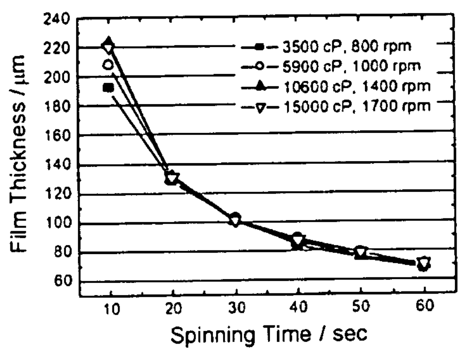

Figure 1. The film thickness variations as a function of spinning time.

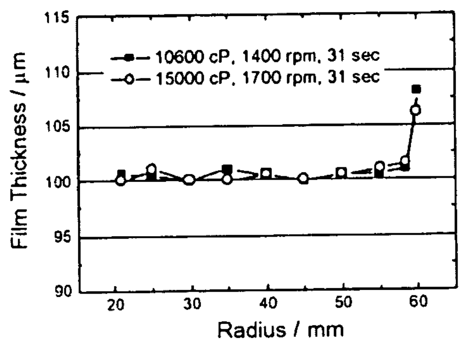

Figure 2. Radial distribution of cover layer thickness.

Table 1. The effects of a conventional vacuum chuck and a newly designed vacuum chuck on ski-jump and ski-jump width.

Condition for 100 μm thick cover layer		3500 cP /800 rpm /33 sec	5900 cP /1000 rpm /32sec	10600 cP /1400 rpm /31 sec	15000 cP /1700 rpm /31 sec
Conventional vacuum chuck	Ski-jump (μm)	54.3	58.5	55.8	56.1
	Sik-jump width (mm)	2.7	2.3	1.7	1.2
Newly designed vacuum chuck	Ski-jump (μm)	16.2	10.1	8.5	6.2
	Sik-jump width (mm)	2.0	1.3	0.8	0.6

References

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